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Turnover of microbial groups and cell components in soil: ^{13}C analysis of cellular biomarkers

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Abstract

© 2017 The Author(s). Microorganisms regulate the carbon (C) cycle in soil, controlling the utilization and recycling of organic substances. To reveal the contribution of particular microbial groups to C utilization and turnover within the microbial cells, the fate of 13 C-labelled glucose was studied under field conditions. Glucose-derived 13 C was traced in cytosol, amino sugars and phospholipid fatty acid (PLFA) pools at intervals of 3, 10 and 50 days after glucose addition into the soil. 13C enrichment in PLFAs (~1.5% of PLFA C at day 3) was an order of magnitude greater than in cytosol, showing the importance of cell membranes for initial C utilization. The 13C enrichment in amino sugars of living microorganisms at day 3 accounted for 0.57% of total C pool; as a result, we infer that the replacement of C in cell wall components is 3 times slower than that of cell membranes. The C turnover time in the cytosol (150 days) was 3 times longer than in PLFAs (47 days). Consequently, even though the cytosol pool has the fastest processing rates compared to other cellular compartments, intensive recycling of components here leads to a long C turnover time. Both PLFA and amino-sugar profiles indicated that bacteria dominated in glucose utilization. 13 C enrichment decreased with time for bacterial cell membrane components, but it remained constant or even increased for filamentous microorganisms. 13 C enrichment of muramic acid was the 3.5 times greater than for galactosamine, showing a more rapid turnover of bacterial cell wall components compared to fungal. Thus, bacteria utilize a greater proportion of low-molecular-weight organic substances, whereas filamentous microorganisms are responsible for further C transformations. Thus, tracing 13 C in cellular compounds with contrasting turnover rates elucidated the role of microbial groups and their cellular compartments in C utilization and recycling in soil. The results also reflect that microbial C turnover is not restricted to the death or growth of new cells. Indeed, even within living cells, highly polymeric cell compounds are constantly replaced and renewed. This is especially important for assessing C fluxes in soil and the contribution of C from microbial residues to soil organic matter.

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